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HURRICANES AND TROPICAL STORMS OF THE WEST COAST OF MEXICO

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ABSTRACT

Records of the Mexican Weather Service for the period 1921 to 1969 show that the West Coast of Mexico is affected more by hurricanes and tropical storms than is the East Coast. Using an arbitrary but probably reasonable criterion of 200 n.mi. as the effective radius of such storms, although there are some smaller storms, we found that the probability of at least one storm per year affecting the West Coast of Mexico is 90 percent or greater in five of the 10 States studied and 74 percent or greater in nine of the 10 States.

The trajectories observed during the months of maximum activity—August, September, and October—are mapped, and a gross climatological storm trajectory is presented. Recommendations for further studies are included.

1. INTRODUCTION

Mexico is one of the few countries of the world affected by hurricanes and tropical storms of two oceans, the Atlantic and the Pacific, and is the one most affected.

For the Atlantic Coastal Plain of Mexico, there are good climatological studies and an adequate warning system; however, for its Pacific Coast (due to data sparsity), there is a weaker climatology and warning system, despite the fact that tropical storms and hurricanes have caused serious damage in that area. For both coasts of Mexico, the records of the Mexican Weather Service at Tacubaya, D. F. (relative to tropical storm occurrences) date back to 1921 and were used in this study.

2. IMPORTANCE TO MEXICO OF HURRICANES AND TROPICAL STORMS ON ITS WEST COAST

Some previous studies of tropical storms in the eastern North Pacific Ocean (Rosendal 1962 and DeAngelis 1967) are concerned with tropical storms of the West Coast of North America, including Mexico, during the period 1947 to 1966. Undoubtedly, they were based on data better than those available to the Mexican Weather Service. The main concern of the author, however, is the tropical storms and hurricanes that have affected Mexico; thus it is believed that the data used here are representative and cover a longer period.

The months of maximum activity are the same on both coasts of Mexico. Figures 1–3 show the trajectories of the tropical storms and hurricanes for the 3 mo of maximum activity (i.e., August, September, and October) during the period under investigation. The trajectories are not identified with regard to storm intensity because the degree of development of most of the storms was unknown. This is due to the data sparsity and the lack of information on the maximum wind speeds in most of the storms.

The trajectory maps (figs. 1–3) were used to derive the gross climatological trajectories of figure 4. These proposed trajectories are biased toward the coast, but they still agree in general with the gross trajectories reported previously (Palmén 1948, Bergeron 1954). There are, however, some important variations because the gross trajectories presented here take into account the fact that a large number of storms move inland, particularly in September and October.

The amount of rain associated with these storms is quite important for irrigation purposes, to the degree that the success or failure of crops in a given area may very well depend on such rainfall. Occasionally, the storms bring rather heavy rains that can cause floods, such as those produced in Mexico in 1968 by Naomi. Sometimes, the strong storm winds cause extensive damage. Several cases of serious damage have been reported—for example, by the hurricane of Manzanillo in 1959, which is one of the best documented (DeAngelis 1967). DeAngelis mentions that, of the 10 most severe storms of the eastern North Pacific in the decade 1957–1966, seven moved inland to Mexican territory. A more thorough study of the storms of the West Coast of Mexico is important for their influence on agriculture and for the development of a storm-warning system.

The usual criterion that a hurricane center must move inland to affect a coastal area is inadequate. On the basis of studies of the structure of hurricanes (e.g., La Seur and Hawkins 1963 and Hawkins and Rubsam 1968) and studies of tropical vortices (e.g., Aspliden et al. 1967), it is possible to arrive at a minimum area that should be affected by the average hurricane or tropical storm along the West Coast of Mexico. A circle with a radius of 200 n.mi., centered on the geometric center of the storm, was chosen for this study. This criterion may be too large for some storms (e.g., Rebecca of 1968, Denney 1969); but again due to the data sparsity, it is impossible to know how many of these very small storms have occurred.

In figure 5 is a comparison of the occurrence of hurricanes and tropical storms on both coasts of Mexico for the period 1921–1969. The monthly frequencies of storms in which the geometric centers passed within a distance of ≤ 200 n.mi. from shore are shown. The number of storms that affected the coast of Mexico is much larger than the number of those that moved onto land. Many more storms affected the West Coast than the East Coast.

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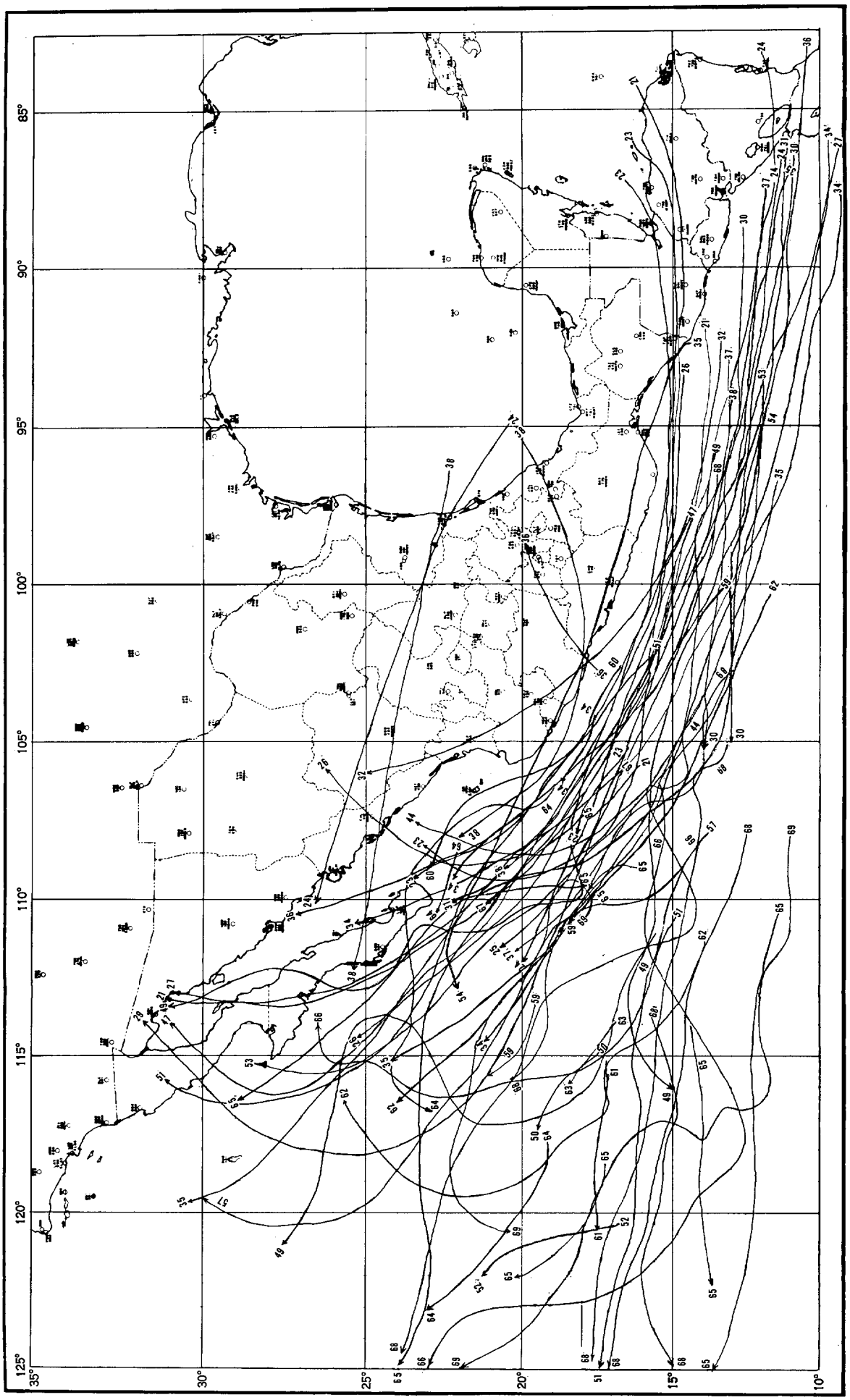


FIGURE 1.—Trajectories of hurricanes and tropical storms during August 1921–1969; the 21 near the trajectory represents the year 1921, the 23 represents 1923, etc.

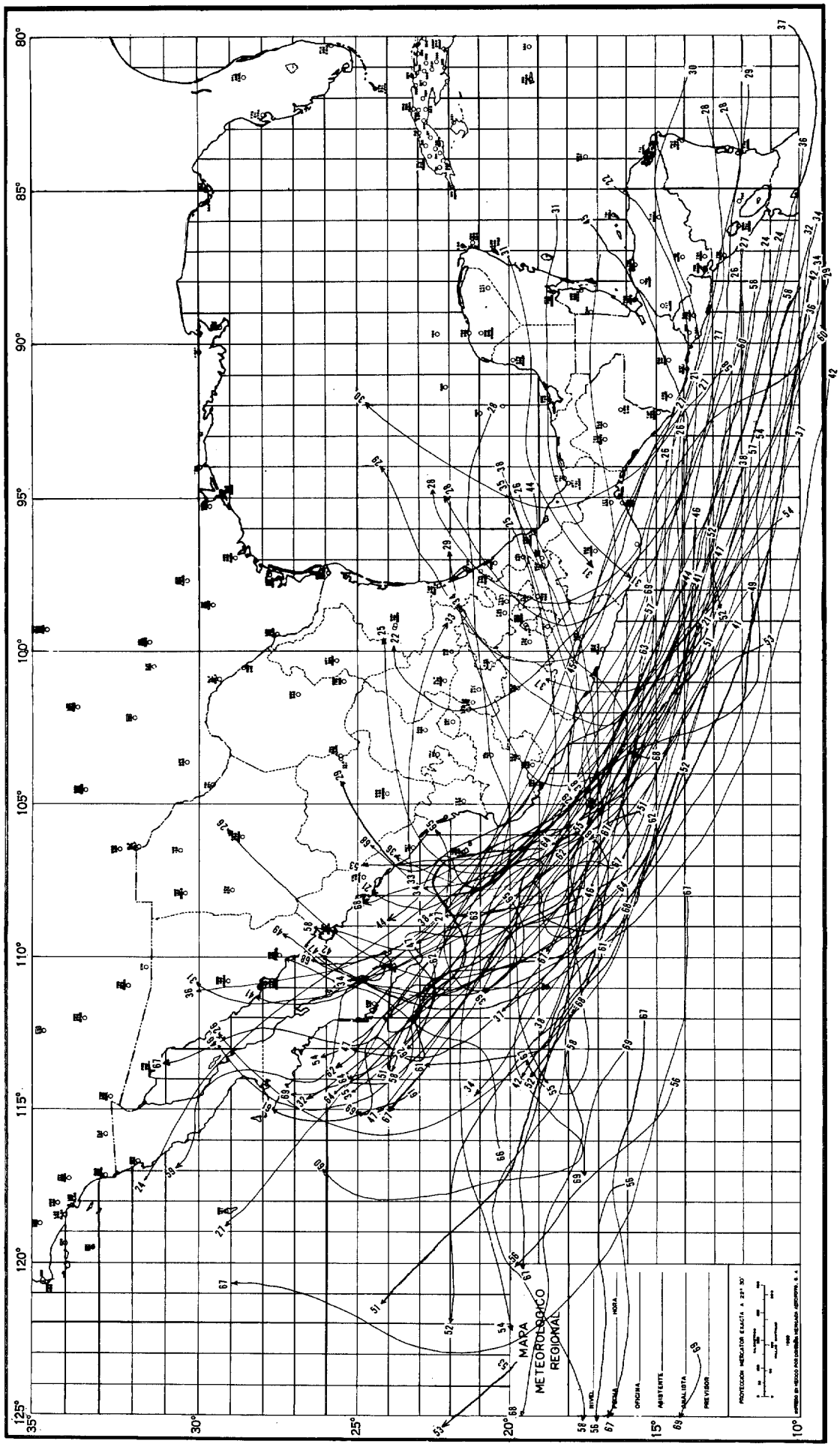


FIGURE 2.—Same as figure 1, except for September.

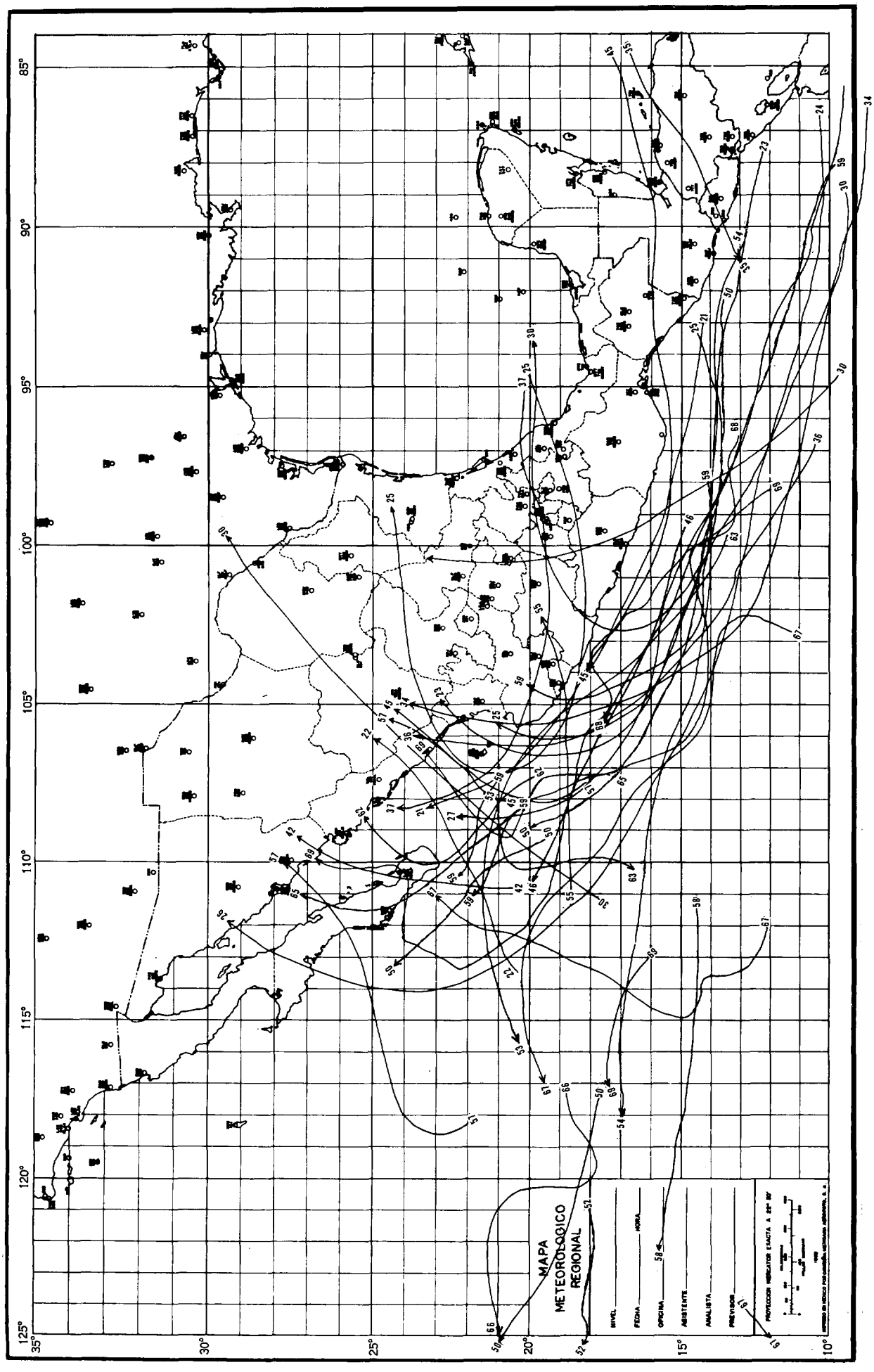


FIGURE 3.—Same as figure 1, except for October.

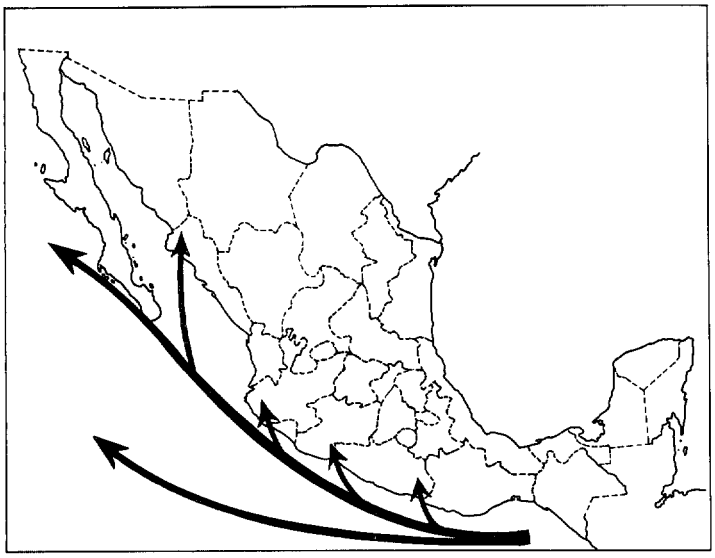


FIGURE 4.—Gross climatology trajectories proposed on the basis of the data in this study.

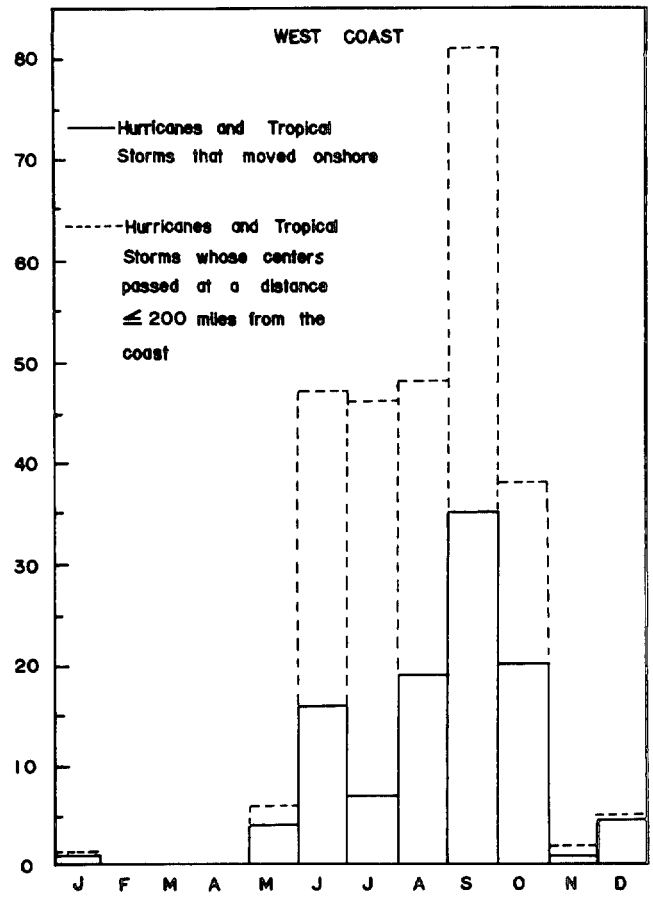
For example, in September (the month of maximum activity on both coasts), a total of 81 storms affected the West Coast; of these, 35 moved inland. The East Coast, however, was affected by a total of 51 storms occurring during the 49-yr period; of these, 25 storms moved inland, 14 of which were hurricanes.

On the basis of observed frequency, the probability that at least one storm would affect or move inland was computed for the 10 States on the West Coast of Mexico. These probabilities are presented in figure 6 where there are several regions in which the probability of being affected is greater than 0.9. The Baja California Peninsula is the most affected, with a 0.97 probability of being affected and a 0.46 probability that at least one storm will penetrate inland. The State with the next highest probabilities is Jalisco, near the center of the coast, with 0.97 and 0.29 probabilities.

Aside from Baja California, it is possible that the probabilities reach a maximum on the tip of Jalisco, with decreasing probabilities both to the north and the south. This indicates that most of the storms moved to the open sea at that point; this is in accordance with the work of Rao (1970) who states, if the east side of the storm is partly over land, friction will cause an increase of motion toward the west-northwest.

3. GENERAL IMPORTANCE OF TROPICAL STORMS ON THE WEST COAST OF MEXICO

Tropical storms and hurricanes that develop over the eastern North Pacific are quite important to land interests in Mexico; but as stated by DeAngelis (1967), they are perhaps even more important to shipping interests in that area. Because they are quite numerous and dangerous, it is important that they be studied in more detail than in the past.



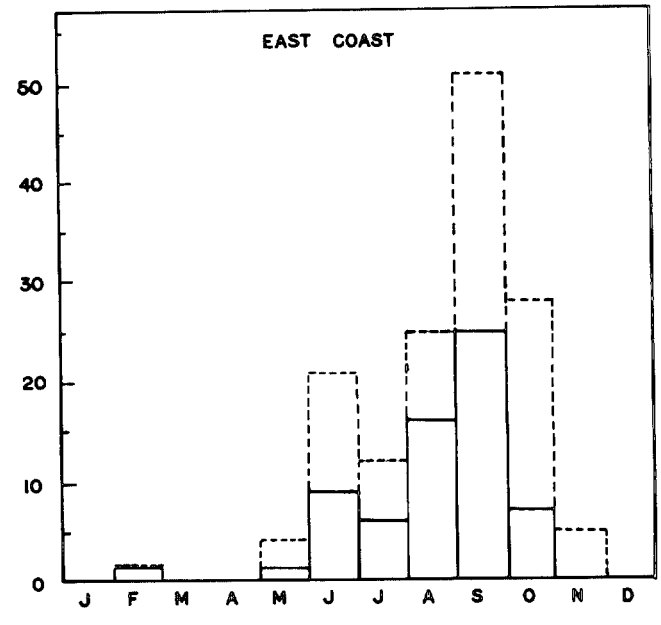


FIGURE 5.—Histogram of the monthly occurrence of tropical storms and hurricanes on both coasts of Mexico for the period 1921–1969. The storms in which the centers moved onshore and those in which the centers passed at a distance of ≤200 n.mi. from shore are indicated.

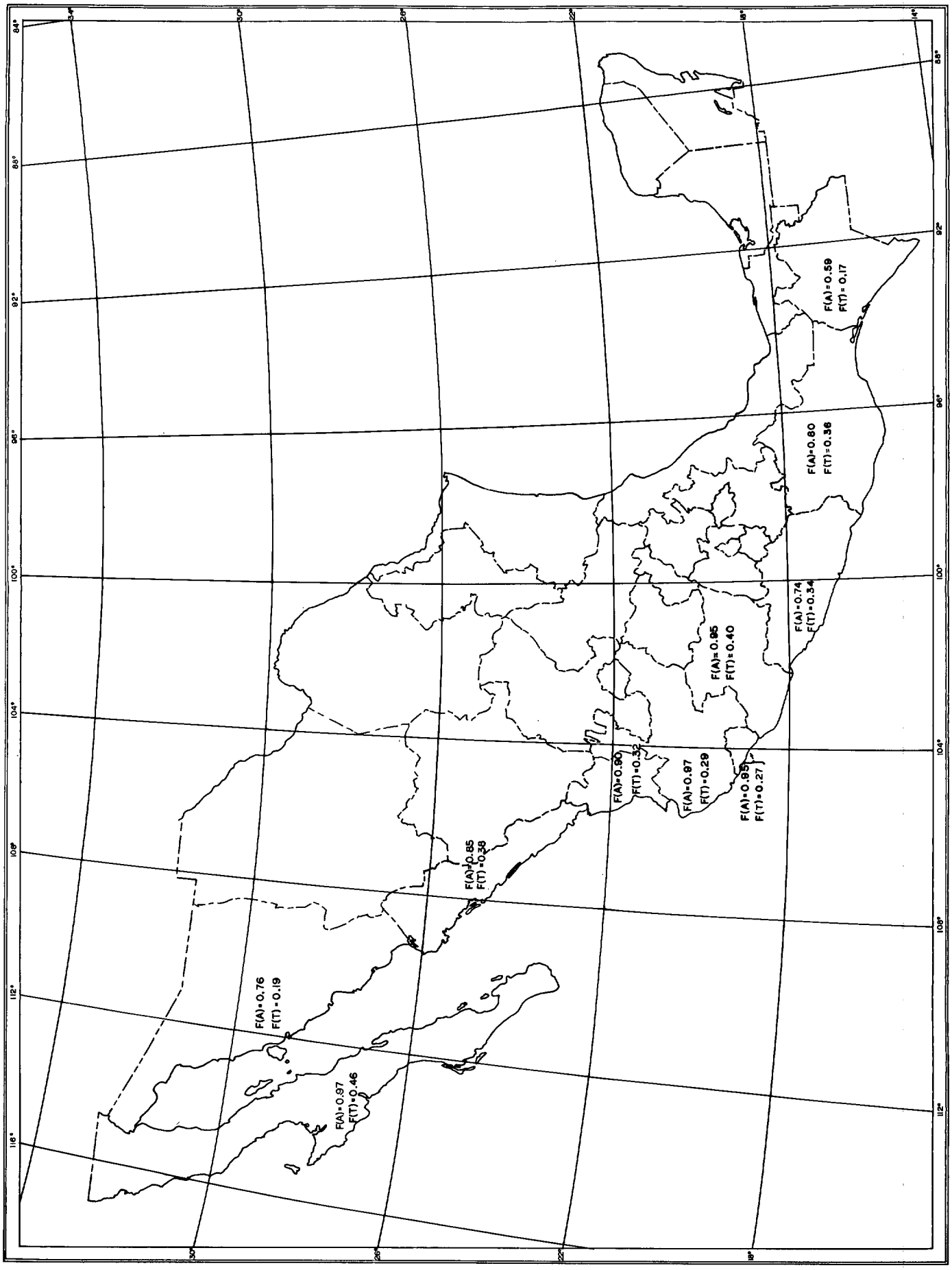


FIGURE 6.—Probability that at least one storm per year will pass ≤200 n.mi. from shore [F(A)] or will move onshore [F(T)] is shown for each of the 10 States of the West Coast of Mexico.

Because of data sparsity in this region, it is necessary to apply the theories that have been developed through studies of hurricanes in other parts of the world. At present, there are only two rawinsondes on the whole West Coast of Mexico, one at Empalme, Sonora (the State across the gulf from Baja California), and the other at Mazatlán, Sinaloa (the State below Sonora). The latter takes only one observation daily. Since the storms were detected (until recent use of satellites and reconnaissance aircraft) only by data from the surface stations (fewer than eight on the West Coast of Mexico), and from weather reports of ships, it is recommended that special emphasis be placed on locating these storms, and after storms are detected, their movement be forecast using the techniques developed for use with hurricanes of the Atlantic. These methods are persistence, climatology, statistical techniques, dynamical techniques, steering currents, etc.

Because these West Coast storms are numerous, and form and intensify relatively close offshore, they should be useful for studies of the conditions that are necessary and sufficient for the development of hurricanes in general. An improved meteorological observational network would be necessary before any exhaustive studies are undertaken.

4. CONCLUSIONS AND RECOMMENDATIONS

Tropical disturbances are frequent on the West Coast of Mexico; the time of occurrence of maximum activity is the same as that on the East Coast, but the number of storms is greater.

Because of data sparsity, it is necessary to improve the meteorological network to provide adequate data for studies of these phenomena. In the meantime, existing knowledge of tropical storms, particularly the knowledge on hurricanes of the Atlantic, should be applied to studies of the storms on the West Coast of Mexico. The high frequency of these West Coast storms suggests their use as a source of data for intensive research.

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